November 29, 2004

Mr. Richard Schumacher
AMEC
Midwest Plaza Building
800 Marquette Avenue, Suite 1200
Minneapolis, Minnesota 55402

Subject: Indoor Air Quality Assessment
State of Iowa Wallace Building

Dear Mr. Schumacher:

AMEC Earth & Environmental performed an indoor air quality assessment at the Wallace State Office Building located in Des Moines, Iowa. James N. Friedman, PE, CIH performed the assessment on November 10, 2004. This report documents the findings and conclusions of that assessment.

EXECUTIVE SUMMARY

The following are the major findings of this study:

1) No potential sources of air contaminants were identified in the Wallace State Office Building that would be considered significant health hazards to building occupants. The air sampling results indicate generally good indoor air quality.

2) The analytical results for particulate matter (PM), volatile organic compounds (VOCs), and formaldehyde indicate airborne concentrations were below recommended guidelines for office buildings.

3) The laboratory analytical data obtained for fungal spores showed no evidence of indoor microbial amplification, as airborne concentrations measured indoors were less than those measured outside at the fresh air intakes to the heating, ventilating, and air conditioning (HVAC) systems.

4) The monitoring results on this date for carbon dioxide (CO_2), carbon monoxide (CO), temperature, and relative humidity were consistent with recommended ASHRAE guidelines.

BACKGROUND

The purpose of this indoor air quality (IAQ) evaluation was to assess current IAQ conditions and determine if there were any significant health hazards to workers who occupy this building. The assessment focused on three primary areas:

- Evaluating potential sources of airborne contaminants: particulate matter (PM), volatile organic compounds (VOCs) and formaldehyde.

- Evaluating potential amplification of fungal spores in the indoor air.

- Monitoring trends of carbon dioxide (CO_2), carbon monoxide (CO), temperature, and relative humidity that are indicators of ventilation effectiveness or general comfort conditions in the building.

The air sampling in the Wallace State Office Building was completed on November 10, 2004 during a normal business day when the building was occupied. The HVAC air-handling units were visually inspected and were operating as normally programmed. The supply air temperatures observed were between 70 and 75 ^{o}F.

Indoor air pollutant air samples were collected for particulate matter, volatile organic compounds, and fungal spores. Measurement locations included the following areas: first floor east, second floor west, fifth floor east, and fifth floor west. Additionally, two fungal spore samples were collected outside, at the HVAC inlet louvers (located on the east side of the building). The air samples were collected in accordance with standard National Institute for Occupational Safety and Health (NIOSH) and Occupational Safety and Health Administration (OSHA) sampling methods. The samples were analyzed by the Wisconsin Occupational Health Laboratory, which is accredited by the American Industrial Hygiene Association (AIHA).

A TSI Model 8762 indoor air quality meter was used to monitor CO_2, CO, temperature, and relative humidity. Measurements were collected at both indoor locations (those identified in the previous paragraph) and outdoors near the main entrance of the building.

AIR SAMPLING RESULTS

Particulate Matter

Average particulate concentrations measured with in the building were below the level of analytical detection. See Table 1. Sources of airborne particulate matter in office buildings typically include printers, dry toner copy machines, and manual handling/cutting/shredding of paper. Elevated indoor particulate levels can also occur when the HVAC filtration systems are not operational or has maintenance deficiencies.

The low particulate concentrations measured in Table 1 suggest these sources are not present. The United States Environmental Protection Agency (EPA) has established an outdoor standard of 150 $\mu g/m^3$ (24-hour average) for particulate matter less than 10 micron in aerodynamic diameter. As seen in Table 1 the particulate concentration levels monitored indoors are significantly less than the standard acceptable for outdoor air.

Volatile Organic Compounds

Table 1 shows the VOC concentrations measured in the building ranged from 0.036 to 0.15 mg/m^3. Several studies have reported VOC concentrations in occupied office buildings.

One study (Daisey 1994) reported VOC concentrations in twelve occupied California office buildings ranged from 0.23 to 7 mg/m^3 with a geometric mean of 0.51 mg/m^3. The results of this study suggest that VOC concentrations in the Wallace State Office Building are below those found in the literature for office buildings.

Although standards for exposure to VOCs in indoor environments do not exist, exposure limits have been recommended. The European Collaborative Action (ECA) Report titled "Guidelines for Ventilation Requirements in Buildings" states that those buildings with VOC concentrations less than 0.2 mg/m^3 are considered to be comfortable for human occupancy. As seen in Table 1 the measured VOC concentrations in the Wallace State Office Building were below the limit recommended in the European report.

Formaldehyde

Health concerns associated with low-level exposure to formaldehyde have included asthmatic/pulmonary irritation, skin irritation, and irritating symptoms (eyes, nose, and throat). The OSHA PEL for formaldehyde is 0.75 ppm for industrial indoor environments. The federal target level or HUD standard for manufactured homes is 0.4 ppm. As seen in Table 1, the measured formaldehyde concentrations in the building are 1 to 2 orders of magnitude less than the OSHA and other federal and state guidelines for formaldehyde.

Fungal Spores

Airborne fungal spore samples were collected to assess ambient (indoor) conditions with respect to mold. Fungal air samples are regarded as an indicator of allergenic disease (asthma, hypersensitivity pneumonitis). Samples were collected at the same indoor locations as for particulates, VOCs and formaldehyde. Additionally, two control samples were collected outside at the inlet to the fresh air intake louvers located on the east side of the building on the third level. Outdoor samples are commonly collected and used for assessing potential amplification of indoor microbial levels.

The laboratory results are presented in Table 2. The table shows the fungal concentration in colony forming units per cubic meter of air and fungal genera encountered. The interpretation of indoor air sample results is highly dependent on outdoor sample results. The outdoor profile is dominated by penicillium sp. and cladosporium sp. Pencillium fungi generally dominate soil populations. Dead or decaying leaf populations are generally dominated by cladosporium sp., which is consistent with fungal genera observed with the outside samples.

The results in Table 2 generally show lower fungal concentrations in the indoor samples when compared to the outdoor samples. This data suggests the HVAC units serving the indoor environment are effectively filtering the fungal spores generated outdoors and entrained in the outside air entering the building. Additionally, Table 2 shows no evidence of slimy spore producing fungal genera such as Stachybotrys. The presence of slimy spore-producing fungal genera is generally associated with moisture problems and mold remediation in the building.

Carbon Dioxide and Carbon Monoxide

A TSI air quality monitor was used to monitor carbon dioxide and carbon monoxide concentrations at the indoor monitoring locations. Table 3 shows the monitoring results.

Carbon dioxide (CO_2) is a non-toxic gas that is frequently used as an indicator of building ventilation effectiveness. Carbon dioxide concentration in a building is dependent upon the amount of "fresh" outside air provided, building occupancy levels, and the efficiency of the ventilation system in distributing conditioned air to building occupants. Sufficient ventilation provides for the dilution of building and occupant generated contaminants and odors. The "peak" threshold for CO_2 in occupied buildings recommended by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) is 1,000 parts per million (ppm). Carbon dioxide levels measured indoors were consistently below 1,000 ppm, which indicates that adequate fresh (outdoor) air is being distributed by the building's HVAC systems.

Carbon monoxide (CO) is a toxic gas that is produced by the incomplete combustion of any fuel-containing atom. The first symptoms to low exposures are headache and fatigue. The United States Environmental Protection Agency (EPA) National Ambient Air Quality Standards (NAAQS) for carbon monoxide in outdoor air is 9 ppm for an eight-hour exposure. The NAAQS limits are values known to cause no adverse effects to human health. They are considered an appropriate limit for indoor environments such as the Wallace building. As seen in Table 3, the CO concentrations in the Wallace Building are approximately 3 times lower than the EPA limit.

Temperature and Relative Humidity

Table 3 summarizes temperature and relative humidity results.

The data collected by the TSI air quality monitor indicated that, during occupied hours, the average temperatures were between 73.7 and 76.3 ^{o}F. The ASHRAE guidelines recommend 74 to 78 ^{o}F during summer months and 68 to 74 ^{o}F during winter months. Since the monitoring was conducted in November and between summer and winter seasons, AMEC considers the temperatures recorded in the building to be appropriate for the season.

The average relative humidity levels were between 26.1 and 27.7 percent during occupied hours, were slightly below the ASHRAE recommended range of 30 to 60 percent. Depressed humidity levels, such as those recorded at the Wallace Building, are relatively common in fall and winter months. This is because the humidification systems in these buildings are not typically operated during seasonal transition period between summer and winter months.

CONCLUSIONS

No potential sources of air pollution were identified in the Wallace Building that would be considered a significant health risk to building occupants. No evidence of fungal growth or amplification was found in the indoor samples.

Some of the reported discomfort expressed by building occupants may be related to more to thermal comfort issues than indoor air pollution. During the air sampling on November 10, 2004, the outside air supply rate as indicated by carbon dioxide readings was well within ASHRAE guidelines. However, additional air quality survey activities (CO_2, temperature, and relative humidity) should be considered during hot and cold weather months, when the HVAC systems operate at minimum outdoor air supply rate.

Please call if you have any questions or if AMEC can assist you in any way.

Sincerely,

AMEC

James N. Friedman, PE, CIH
Certified Industrial Hygienist

Attachments: Tables 1, 2, and 3
Exhibit A Laboratory Results

TABLE 1

STATE OF IOWA WALLACE BUILDING
AREA AIR SAMPLING RESULTS

PARTICULATE, VOC, AND FORMALDEHYDE
NOVEMBER 10, 2004

Sampling Location	Measured PM	PM Indoor Guideline (1)	Measured VOC	VOC Indoor Guideline (2)	Measured Formaldehyde	Formaldehyde Indoor Guideline (3)
1st Floor East	< 57 µg/m^3	150 µg/m^3	0.036 mg/m^3	0.2 mg/m^3	0.006 ppm	0.4 ppm
2nd Floor West	< 57 µg/m^3	150 µg/m^3	0.15 mg/m^3	0.2 mg/m^3	0.009 ppm	0.4 ppm
5th Floor East	<56 µg/m^3	150 µg/m^3	0.076 mg/m^3	0.2 mg/m^3	0.011 ppm	0.4 ppm
5th Floor West	<55 µg/m^3	150 µg/m^3	0.063 mg/m^3	0.2 mg/m^3	0.010 ppm	0.4 ppm

NOTES:

(1) National Ambient Air Quality Primary Standard for Particulates Less Than 10 Micron in Aerodynamic Diameter, Maximum 24-hour Average for outdoor door air as set by the U.S. Environmental Protection Agency.

(2) Indoor standard for exposure to VOCs does not exist. The European Report titled: "Guidelines for Ventilation Requirements in Buildings" states VOC exposures less than 0.2 mg/m^3 indicates a comfortable target level for human occupancy in buildings.

(3) Housing and Urban Development (HUD) target level for manufactured homes. Minnesota standard for indoor exposure (MN stature 144.495).

TABLE 2

STATE OF IOWA WALLACE BUILDING
AREA AIR SAMPLING RESULTS

FUNGAL SPORES
NOVEMBER 10, 2004

ANALYTE/FUNGI	SAMPLE LOCATION					
	1st Floor East	2nd Floor West	5th Floor East	5th Floor West	Ambient Sample 1	Ambient Sample 2
Total Fungal Spores	**755 CFU/m^3**	**247 CFU/m^3**	**92 CFU/m^3**	**117 CFU/m^3**	**1,573 CFU/m^3**	**1,424 CFU/m^3**
Altermaria sp.	1 CFU/m^3	5 CFU/m^3	—	—	22 CFU/m^3	16 CFU/m^3
Aspergillus ochraceus	—	5 CFU/m^3	—	—	11 CFU/m^3	—
Aspergillus fumigatus	—	5 CFU/m^3	—	—	—	—
Aspergillus nidulans	—	—	5 CFU/m^3	—	—	—
Basidiomycete	—	—	—	—	5 CFU/m^3	11 CFU/m^3
Cladosporium sp.	470 CFU/m^3	190 CFU/m^3	46 CFU/m^3	92 CFU/m^3	1,100 CFU/m^3	1,100 CFU/m^3
Fusarium sp.	—	—	—	—	5 CFU/m^3	11 CFU/m^3
Paecilomyces variotii	—	—	—	5 CFU/m^3	—	—
Penicillium sp.	280 CFU/m^3	42 CFU/m^3	31 CFU/m^3	20 CFU/m^3	430 CFU/m^3	270 CFU/m^3
Ustilago sp.	—	—	10 CFU/m^3	—	—	—
Trichoderma harzianum	—	—	—	—	—	16 CFU/m^3
Other	—	—	—	—	—	—

NOTES:
(1) CFU represents colony forming units per cubic meter of air sampled.

TABLE 3

STATE OF IOWA WALLACE BUILDING
AREA AIR SAMPLING RESULTS

CARBON DIOXIDE, CARBON MONOXIDE TEMPERATURE, AND RELATIVE HUMIDITY
NOVEMBER 10, 2004

Sampling Location	Average PPM CO_2	ASHRAE Guideline (1)	Average PPM CO	ASHRAE Guideline (2)	Average DB Temp.	ASHRAE Guideline (3)	Average % RH	ASHRAE Guideline (3)
1st Floor East	448 ppm	1,000 ppm	2.4 ppm	9 ppm	73.7 °F	68 – 74 (W) 74 – 78 (S)	27.7%	30 to 60
2nd Floor West	496 ppm	1,000 ppm	2.5 ppm	9 ppm	75.4 °F	68 – 74 (W) 74 – 78 (S)	27.2%	30 to 60
5th Floor East	503 ppm	1,000 ppm	2.5 ppm	9 ppm	74.8 °F	68 – 74 (W) 74 – 78 (S)	27.7%	30 to 60
5th Floor West	506 ppm	1,000 ppm	2.6 ppm	9 ppm	76.3 °F	68 – 74 (W) 74 – 78 (S)	26.1%	30 to 60
Outdoors (4)	345 ppm	——	3.5 ppm	9 ppm	63.5 °F	——	36 %	——

NOTES:

(1) ASHRAE Guideline 62-1999, “Ventilation for Acceptable Indoor Air Quality”.

(2) National Ambient Air Quality Primary Standard for Carbon Monoxide, 8-hour average for outdoor door air as set by the U.S. Environmental Protection Agency.

(3) ASHRAE Guideline 55-1991, “Thermal Environmental Conditions for Human Occupancy”. (W) means winter months, (S) means summer months.

(4) Readings outdoors were taken near the front entrance of the building facing the state capital building.

EXHIBIT A

LABORATORY ANALYTICAL REPORTS